**Progress Toward a Pressure Standard using Argon-Filled Microwave Cavity Resonator**

James W. Schmidt [C, S] and Michael R. Moldover
*NIST, Sensor Science Division, Gaithersburg, MD, U.S.A.*
*jschmidt@nist.gov*

We report progress in developing a pressure standard based on measurements of the resonance frequencies of an argon-filled, microwave cavity resonator at the temperature $T$. The standard will operate in the pressure range (0.1 to 7) MPa and will rely on our measurements of the ratio, $R(p,T)=n_{Ar}(p,T)/n_{He}(p,T)$ = (refractive index of argon)/(refractive index of helium). We measured the ratio, $R(p,T)$, with an uncertainty of approximately $5\times10^{-9}$ by measuring the resonance frequencies of two nearly identical cavities, at nearly identical temperatures and pressures. One cavity was filled with helium the other with argon. Interchanging the gases in the cavities removed the effect of the apparatus' compressibilities. Measurements were made at 3 temperatures; the mercury point, the triple point of water and the gallium point. They demonstrate the expected insensitivity of the polarizability of inert gases to temperature in the limit of zero density. Combining our values of $R(p,T)$ with the refractive index of helium from theory, we obtain values of $n_{Ar}^2(p,T)_{NIST}$ that have a total uncertainty of approximately $u(n_{Ar}^2)\sim13\times10^{-9}$ $(1+1.0p/\text{MPa}+0.4p^2/\text{MPa}^2)$ with a 68 % confidence level ($k$=1). These results can be used to convert measurements of $n_{Ar}^2$ in the field to pressure. The total relative uncertainty in pressure will be approximately

$$u(p)/p \sim (R_gT/(A_{Ar}\,p))[u^2(n_{Ar}^2)_{NIST}+u^2(n_{Ar}^2)_{field}+u_r(k_BT)]^{1/2} \sim 10^{-6}\,[2.3(\text{MPa}/p) + 2.1 + 0.8(p/\text{MPa}) + 1.4].$$

In this estimate we use the 2010 CODATA value $u_r(k_BT) = 0.91\times10^{-6}$ and our ability to realize the temperature of the triple point of water inside the cavity resonators within +0.3 mK.